



ORIGINAL RESEARCH PAPER

**Community empowerment of waste management in the urban environment:
More attention on waste issues through formal and informal educations**

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ARTICLE INFO

Article History:

Received ***

Revised ***

Accepted ***

Keywords:

Awareness
Behavior
Education
Littering
Logistic regression
Waste management

ABSTRACT

BACKGROUND AND OBJECTIVES: Indonesia's economic growth is estimated to be driven by high levels of consumption which lead to large amounts of waste. Education is required to raise environmental awareness among the population as it is one of the ways to overcome the waste issue, especially in urban areas, which are the engines of economic growth. This study aims to determine whether the higher levels of education have a greater impact on citizens regarding environmental concerns such as littering.

METHODS: The study took logistics regression on the primary data survey from 7 cities (Jakarta, Jambi, Muaro Jambi, Ambon, Padang, Surabaya, and Tasikmalaya) in Indonesia during 2019-2021. The survey includes 563 observations on the household level, involving a total of 2,349 respondents. The logistic regression predicts the likelihood of urban citizens to litter, given their socio-economic backgrounds and existing littering behavior and environmental awareness.

FINDINGS: This study found that education did not affect decreasing the value of littering behavior as expected since it is estimated that an increase of 1 year in school will increase the probability of littering by 0.0189. Formal education is not enough to decrease the probability of littering behavior on the individual level. In contrast, informal education taught on keeping a clean environment matters is better than conventional formal education. Besides that, having self-initiative on environmental caring and good habits from childhood will decrease the probability of littering on an individual level. An individual has a self-initiative, the probability of littering will be 0.1732 times lower than those who do not have self-initiative. This study also found that per capita income and per capita expenditure in big cities in Indonesia ranged between USD 156,903 and USD 116,857. These economic factors affect the behavior of citizens not to litter. The per capita expenditure increasing by USD 1 per person per day will decrease the probability of littering by -0.0468. However, these factors are not enough to minimize the littering behavior since the disposal place availability becomes another keys factor in decreasing littering behavior on urban citizens.

CONCLUSION: The government should also focus on building citizens' behavior regarding waste management awareness especially building good habits since childhood and individual initiative, simultaneously implementing the programs to reduce waste production.

DOI: [10.22034/gjesm.2022.02.05](https://doi.org/10.22034/gjesm.2022.02.05)

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NUMBER OF REFERENCES

52



NUMBER OF FIGURES

3



NUMBER OF TABLES

3

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Note: Discussion period for this manuscript open until July 1, 2022 on GJESM website at the "Show Article".

INTRODUCTION

Indonesia is listed in the top 5 of the most populous countries in the globe, resulting in bigger various economic activities compared to its peers in the Association of Southeast Asian Nations (ASEAN) region. In the real sector, big economic activities will be followed by waste production. The waste itself takes part in the economy in the middle phase: as value-added, delivery, or packaging. After the output produced has been absorbed by the economy (consumed by economic agents), the residue of what-so-called value-added, delivery, or packaging will turn into a new phase: a waste. Waste is defined as the residue of real economic activities within a period. Indonesia, as the world's biggest archipelago, has agglomerated structure of economic activities. Both production and consumption activities are concentrated in the urban environment, and this study tried to explain what might cause a waste problem that comes from Indonesia's biggest economic growth contributor households. Cities are synonymous with high density and waste management problems (Brotosusilo and Handayani, 2020). The increase in the world's population living in urban areas indicates the possibility of an increase in the volume of waste which will eventually become a pressure for cities (World Bank, 2018). Increased income and consumerism also affect the high amount of waste produced in cities. Suleman et al. (2015) describe that the rapid increase in living standards and technology leads to higher solid waste production. Households in urban areas have a lower probability of burying or burning waste but piles of garbage in public places are more common, which has an impact on the environment and citizens (Adzawla et al., 2019). The discovery of piles of waste can be found in the streets or halted and public places, most of which are in the form of leftover food or beverage packaging. Littering behavior is also known to be influenced by spatially based attributes. It means that areas with lots of drink shops, empty buildings, or areas close to roads will have a higher tendency to litter than housing with green and well-maintained spaces (Weaver, 2015). Humans interact with nature, and this can affect ecosystem, economic, and cultural resilience on local and regional scales (Folke and Gunderson, 2002). The littering of waste can shake the resilience of the ecosystem. Waste littering is caused by a lack of environmental awareness

(Eastman et al., 2013). The development of study shows that this plastic waste will not only interfere with aesthetics but can also have an impact on health. There is some evidence found related to the impact of littering, both in the terrestrial and aquatic environment (Jefferson, 2019). Waste management to achieve the Sustainable Development Goals (SDGs) by reducing waste generation through the reuse, reduce, and recycle (3R). There have been many previous studies exploring household behavior in waste management. Human behavior can be regulated by prevailing social norms. When littering is not reprimanded, it will lead to littering by other individuals. Individuals tend to adopt behavior adapted from socio-spatial contexts (Cialdini et al., 1990). Some policies regarding the payment of plastic bags have been made (McIlgorm et al., 2011). It aims to minimize the use of waste. However, the policies made are not going well in Indonesia. The presence of piles of waste on the road, river, or sea has attracted a lot of attention. The waste problem does not only come from within the country; there are reports of waste exports from developed countries to developing countries (World Bank, 2018). The enforcement of regulations is accused of being the cause of littering behavior because the existing sanctions are not strictly enforced (Kedzierski et al., 2020). Several approaches are taken to solve the problem of waste littering, either through technical approaches or social knowledge. The constraint is that it is impossible to tackle waste using only one approach. It is necessary to combine approaches because of the complex waste problem. The problems that occur come from the amount of waste itself and its littering behavior. Differences in waste management in cities of Indonesia are caused by differences in people's understanding of a healthy and clean environment. Ignorance of waste is also the cause (Brotosusilo and Handayani, 2020). Improper waste management behavior is still being carried out, burning waste is still very common to destroy waste (Hilburn, 2015). Therefore, awareness about waste disposal and the action of identifying human behavior harms the environment should be more improved as it facilitates behavior change (McNicholas and Cotton, 2019). Several studies state that the factor that influences littering is the level of education. Efforts can be made by providing education to maintain

environmental sustainability ([Eastman et al., 2013](#); [Bahri et al., 2020](#)). In making decisions and in acting so as not to have harmed the environment, it is influenced by the level of education ([Dodds and Holmes, 2018](#)). Waste can be prevented and controlled through collaborative education and policy enforcement ([Ten-Brink et al., 2009](#)). Environmental education must pay attention to the media used in both formal and informal education. The use of this media has the aim of enriching intellectual work tools ([Cuc, 2014](#)). [Alexander et al. \(2009\)](#) mentioned that the obstacle in pro-environmental behavior is knowledge where individuals with less education will litter more. Formal education plays a role in the proper level of waste management. From the household side, the socio-economic variables that may cause households' behavior in littering were explored. The key variables explored will relate to education and prior knowledge of urban citizens. This study may fill the gap on how urban citizens in Indonesia show unique behavior in littering. This environmental behavior occurs when there is a role for self-interest and pro-social motives. Pro-social behavior will create a moral value as a feeling of strong obligation that wanted to be involved in pro-environmental behavior. Social norms are in the form of behavior patterns, beliefs, and practices of pro-environmental behavior. Strong norms will prevent littering ([Bator et al., 2010](#)). An order that is enforced, not just order because of the rules, can influence someone to be willing to follow the norm ([Keizer et al., 2013](#)). Restoration or enforcement of social norms may be able to spread pro-social behavior to others. Disrespect decreases in association with sanctions the stronger variable is cues that convey explicit attention to norms ([Keizer et al., 2013](#)). One effort that shows results is that it is not enough to maintain cleanliness, individuals need examples or role models. Perform cleaning when there are people in the area so they can emulate them. In developing moral norms, cognitive prerequisites are needed in the form of awareness and knowledge of environmental problems ([Bamberg and Moser, 2007](#)). [Bamberg and Moser \(2007\)](#) conducted a meta-analysis of the factors that influence pro-environmental behavior. The determinant factor for proliferative behavior is intention. The intention is defined as a summary of the interaction of cognitive skills, action knowledge, action strategies, and problems with behavioral

variables, attitude, control, and responsibility. Waste disposal depends on the socio-economic status and location of the settlement ([Alhassan et al., 2020](#)). Education is one of the most important factors in reshaping and improving human behavior, including the littering behavior of urban citizens. This study focused on how education matters to urban citizens' behavior to create a clean and healthy living. Environmental attitudes are related to feelings, expansion of the physical environment, environmental services/products ([Leonidou et al., 2015](#)). Environmental problems originating from waste are caused by littering behavior ([Bator et al., 2010](#)) will carry out the behavior of littering if in the area he has seen or discovered the existence of waste scattered before ([Schultz et al., 2011](#)). The scattered waste means that the surrounding community tolerates the behavior of littering ([Weaver, 2015](#)) when there is an irregularity in the behavior of throwing waste. It will be difficult to rebuild the order of littering of waste in the area. This does not necessarily encourage individuals to litter but behavior control also plays a role in individual initiatives not to litter. Socio-economic factors influence household decisions in solid waste disposal. It was found that education, gender, and age had a significant effect on the choice of waste littering ([Adzawla et al., 2019](#)). The characteristics and location of a household also influence how household waste is littered of. Waste littering is divided into several systems, namely house to house (HtH), communal, informal waste collector (INF) systems, and illegal disposal. Waste littering in the HtH system is littering where households litter their waste in the trash in front of the house, and cleaners from the city government collect the samples. Citizens who litter waste according to this system are influenced by gender after age, income, household size, work sector, and homeownership status ([Alhassan et al., 2020](#)). A communal waste-littering system occurs when a landfill is provided for citizens in one area. When littering waste, the citizens have to collect the waste in a communal container where the cleaning staff will collect the trash in the communal place, instead of one house to another. When households do not entrust their waste littering to the city government, they will call informal waste workers called Informal waste collectors (INF). The waste produced by the household is purchased by INF so that the household

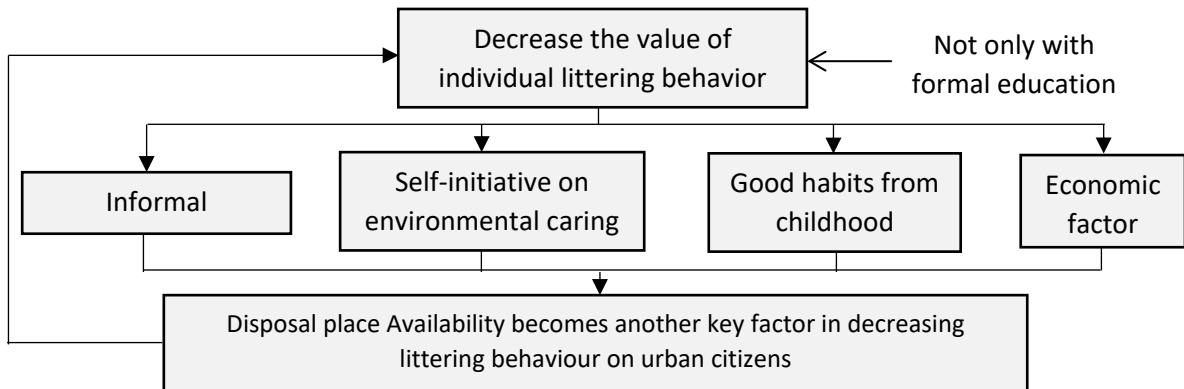


Fig. 1: Framework concept to decrease the value of individual littering behaviour

will get additional income from waste production paid for by INF. This study tried to analyze if the higher education of citizens will have more impact on the attention in the environment, focusing on the waste littering awareness as in [Ningrum and Herdiansyah \(2018\)](#). This awareness is a new aspect considering that people's awareness of their environment is quite low as found in many studies. Based on this, the study is focused on waste littering awareness considers that most people dispose of waste by burning it. The survey was conducted in 7 cities (Jakarta, Jambi, Muaro Jambi, Ambon, Padang, Surabaya, and Tasikmalaya) in Indonesia during 2019-2021.

MATERIALS AND METHODS

Data description and collection

The data used was primary data. This primary data was obtained through a survey with more than 2000 respondents. The survey includes 563 observations on the household level. The households contain a various number of family members, with a total of 2,349 respondents on the individual level. The questionnaire used consists of 2 main sections: household ([Adzawla et al., 2019](#)) and individual section. The household section profiles the data of respondents' entire household data, including the members and their education levels, age, and marital status ([Al-Khatib et al., 2019](#)). The household section consists of 3 subsections and is filled by the household's representatives. The individual section consists of 4 subsections that profile different aspects of individual littering behavior ([Alexander et](#)

[al., 2009; Brotosusilo and Handayani, 2020](#)). These individual subsections are filled individually by household members. The survey has been conducted on the most populous cities in big provinces (by populations) in Indonesia. The provinces that were observed are the Special Administrative Region of Jakarta, Jambi, West Java, East Java, Maluku, and West Sumatera. The cities were observed in this survey are all administrative sub-regions in Jakarta, Jambi, Muaro Jambi, Ambon, Padang, Surabaya, and Tasikmalaya. The study was conducted in 2019-2020 and qualitative research was carried out in 2021 under the conditions of the Covid-19 pandemic so that it was carried out taking into account strict health protocols. The survey itself took more than 3 sessions to break down many aspects of littering behavior. Multiple sessions on the questionnaire were used for general socio-economic profiling (such are incomes, expenditures, and educations of each family member) while the rest phases cover specific aspects of waste-handling behavior. The framework concept could be seen in [Fig. 1](#).

All sessions on the questioner consist of more than 80 questions to enlarge research possibilities. This study will not explain all of the survey results. This study focuses on what factors might cause an individual to litter. In other words, this study used 4th phase of the survey. The sampling method used in this survey was random purposive sampling. The random households were taken from intended locations that have waste management problems with a high amount of populations. After the households have been chosen, the other family members were asked about

their behavior in littering. Hence, the data of waste-handling behavior within the same family might differ from each other.

Economic modeling and regression method

The dependent variable is where the respondent throws a waste. Various places to throw waste are mentioned on the survey; hence, it has been converted the multiple choices into a dummy variable. The (dependent) dummy variable is called 'litter', which the value of 1 means the respondent threw waste to places other than the trash bin. Littering has been defined as an individual decision to throw waste in an incorrect place or littering space. With a dummy variable for litter as the dependent variable, this study examined how other variables might affect the probability of an individual throwing waste to the incorrect place. This survey defined incorrect places as any other places than a trash bin, a final littering site (FDS), and any other spaces allocated as the littering site. In the case of Indonesia that has been summed on the survey, the places where not supposed to be thrown a waste are rivers, roadsides, drainages, and house yards. The results will show the interpretation in a detailed explanation. This study, as previously mentioned, will focus on the education and prior knowledge of respondents as the main factors influencing their likelihood of littering. The regression model is specified as Eq. 1.

$$P = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_7 X_7 + \varepsilon)}} \quad (1)$$

Where;

P = Probability of littering

e = exponential number

$\beta_0 - \beta_7$ = coefficient parameters

X_1 = Education level (years)

X_2 = Expenditure per Capita/day (United States Dollar (USD))

X_3 = Dummy of Educated enough (environmental education exposure) to keep clean the environment (1= Yes)

X_4 = Dummy of Self-initiative of keep clean (1 = Yes, I have)

X_5 = Dummy of Good Habit (not to litter since childhood; 1=Yes)

X_6 = Dummy of Trash Bin Unavailability (1 = not available)

X_7 = Income per capita/day (USD)

ε = Error terms

Seven independent variables (X_1 to X_7), are proposed where three of them are continuous (education level, expenditure, and income per capita). Another variable used is the socio-economic profiling variable, and the rest four variables are dummies. Data education levels are stated in years of formal education that existed in Indonesia, which consists of elementary school (6 years), junior high school (3 years), senior high school (3 years), and bachelor (4 years). Expenditure (X_2) and income (X_7) per capita per day collected are stated in Rupiah but have been converted to USD as of the time the data were collected. Those 3 variables are the socio-economic profiling variables that have been used to profile the respondent's economic status and behavior, according to their wealth and formal education attained. The dummy variables used are dummy of educated enough to keep clean the environment, self-initiative to keep the environment clean, good habit (not to litter) since childhood, and trash bin availability. The dummy variable of educated is found to be enough to keep clean the environment. It means that the respondents have obtained an informal method of education in the form of social advice to not litter, slogans, warnings, local officers' instruction, and announcements, and citizens' local meetings held to conduct environmental cleansing. The dummy variable of self-initiative of keep clean is profiling variables whether the respondents are caring enough to their living environment, and have some initiative to clean up when it's dirty. The dummy variable of good habits since childhood is a profiling variable. It will determine whether the respondent has had a good environmental habit (not littering) since childhood. These questions are included in the survey since childhood exposure to good habits could shape an individual's habits in the future. The dummy variable of trash bin unavailability is the dummy variable to profile whether there is a trash bin near the respondents' living environment. This variable is to cover the possibility of littering behavior due to lack of waste-handling infrastructure (external factors) rather than the behavioral (internal) factors, or socioeconomic factors.

RESULTS AND DISCUSSION

Waste issues

Every year, waste production in Indonesia increases. In 2019, Indonesia generated 64 million tons of waste ([Kompas, 2020](#)). Organic waste accounts for 60% of total waste produced, with plastic waste accounting for 15%. Waste originating from land also affects the waters, which becomes plastic waste deposition in rivers and the sea ([Carpenter and Wolverton, 2017](#)). It is proven by World Bank data from 2018, 87 cities along Indonesia's coast contributed waste to the sea, which was estimated to be around 1.27 million tons ([Permana, 2019](#)). This number of wastes is because of the increase in both production and consumption ([Fig. 2](#)). These are concentrated in the urban environment making cities in Indonesia are surrounded by waste management problems. Based on this number of wastes produced, it is expected that Indonesia's economic growth will be fueled by high levels of consumption, which results in large amounts of waste.

Urban waste in the urban environment is an expansion caused by a population explosion due to both birth mortality and urbanization. The increase in the volume of global waste has increased higher than the increasing urbanization ([Hoomweg and Bhada-Tata, 2012](#)). According to [Weaver \(2015\)](#), urban citizens have more potential to litter. Contrary to the opinion of others, urban people litter less than rural areas ([Finnie, 1973](#)). Urban households are more environmentally friendly than rural ones ([Fransson and Garling, 1999](#)). Those who live in rural environments tend to litter more than their urban counterparts ([Schultz et al., 2011](#)). The increase in the amount of waste will cause the problem of the amount of waste in the final processing site (TPA) to become uncontrollable ([McNicholas and Cotton, 2019](#)). The problem of waste is still often neglected compared to pollution and heavy metal contamination because waste is considered to only provide aesthetic problems while contamination causes health problems ([Finnie, 1973](#)). The percentage of waste types that are mostly

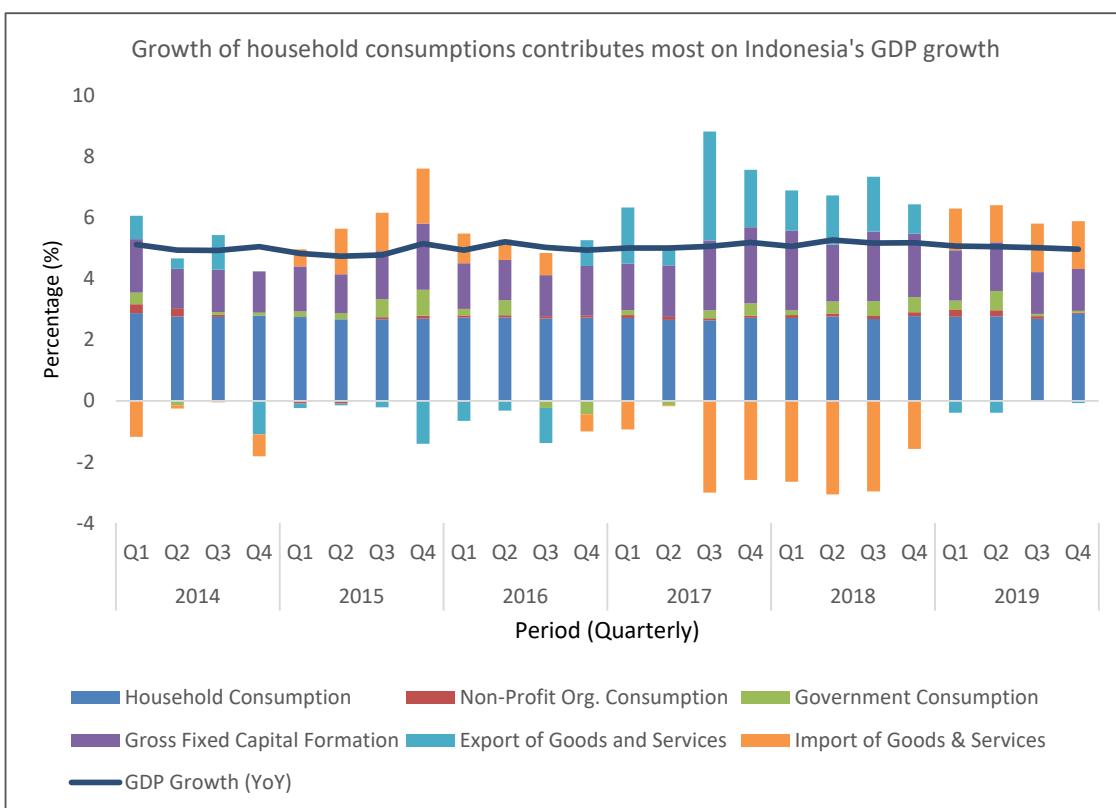


Fig. 2: Contribution to gross domestic product (GDP) growth by expenditure accounts ([BPS, 2020](#))

Table 1: Summary statistics of income and expenditure per capita

Province	West Java	Jakarta	Jambi	West Sumatera	Maluku	East Java	Total
Income per capita (IDR)							
Mean	96,852	146,842	156,402	156,564	255,424	125,317	156,903
S.D.	37,804	60,924	88,833	106,482	185,680	31,752	104,109
Frequency	27	95	88	97	59	100	466
Expenditure per Capita (IDR)							
Mean	119,630	102,737	103,385	100,673	178,571	102,172	116,857
S.D.	70,791	43,958	51,291	38,916	123,483	34,054	72,049
Frequency	27	95	96	99	91	99	507

produced are plastic and metal waste. Plastic waste comes from grocery bags, containers, polystyrene cups; while metal waste originates from beverage and food cans, perfume containers, glass; and organic waste comes from the cooking residue (McIlgorm *et al.*, 2011). Solid waste is divided into biodegradable and non-biodegradable (Hoomweg and Bhada-Tata, 2012). One of the most produced and dangerous waste is plastic (Jefferson, 2019), this is because most of the plastics used are single-use plastics; even though there are plastics that can be recycled, only a few percent are recycled. Plastic waste is common or dominating, where this waste comes from grocery bags, beverage packaging, and aluminum (Carpenter and Wolverton, 2017). The increase in the amount of plastic waste occurred due to a shift in packaging from traditional to plastic materials (Kedzierski *et al.*, 2020). The relatively easy manufacturing process and more affordable prices are the reasons for the use of plastic as food wrappers. There have been efforts to reduce plastic waste by prohibiting the use of plastics and replacing them with more biodegradable paper bags. It is necessary to have an understanding which is not only related to waste, but also its impact on health as a way to improve waste management so that the littering behavior can be reduced (Brotoсило and Handayani, 2020). The correlation between environmental attitudes and responsible behavior towards the environment shows a positive relationship (Fransson and Garling, 1999). It should be noted that there is a difference between ecological attitudes and ecological behavior. Attitude is stated by the existence of the intention of the perpetrator. This intention comes from the perception that whether the activity provides benefits while the behavior is the final behavior pattern

carried out by the perpetrator (Fraj and Martinez, 2006). Human behavior connects cognition (social and psychological) and human action, namely social and biophysical (Alessa *et al.*, 2003). Factors that influence environmental responsibility include attitudes, knowledge, and norms (Fransson and Garling, 1999). Pro-environmental behavior may be affected by individual awareness, environmental education, and social norms (Dodds and Holmes, 2018). Environmental behavior is essential in waste management as it aims to minimize risks for the next generation (Bamberg and Moser, 2007).

Summary statistics

The summary statistics of the respondents are grouped by the province. The summary statistics show that samples in Maluku have the highest income per capita, followed by West Sumatera, Jambi, Jakarta, East Java, and West Java. Respondents in Maluku also have the most expenditure per capita compared to the other provinces sampled. The table of summary statistics of income and expenditure per capita is stated in Table 1.

Probability to litter not in place

In logistic regression, there are two ways of interpretation: marginal effect and odds ratio. The possible estimations have been tested, where the last estimate includes the dummy of the province recorded. Yet, due to low data variability in 1 province, there come 3 best possible estimations explaining the impact of education and prior knowledge on littering behavior. This study will use both continuous and dummy variables collected from the survey to provide a deeper understanding of littering behavior. Regression estimation stated

Table 2: Regression result, dummy variables are interpreted through odds ratio

	(1)	(2)	(3)
	Estimation1	Estimation 2	Estimation 3
Variables	Probability of littering	Probability of littering	Probability of littering
Education Level (Years)	0.0252 (0.0183)	0.0332* (0.0190)	0.0189 (0.0184)
Expenditure per Capita/day (United States Dollar (USD))	-0.0283** (0.0139)	-0.0294* (0.0174)	-0.0468*** (0.0159)
Educated enough to keep clean the environment (1= Yes)	0.1151*** (0.0180)	0.1097*** (0.0177)	0.1269*** (0.0202)
Self-initiative of keep clean (1 = Yes, I have)	0.1421*** (0.0225)	0.1372*** (0.0224)	0.1732*** (0.0287)
Good Habit (not to litter since childhood; 1=Yes)	0.2891*** (0.0632)	0.2638*** (0.0582)	0.3040*** (0.0665)
Trash Bin Unavailability (1 = not available)			3.056*** (0.8000)
Income per Capita/day (USD)		-0.00453 (0.0121)	
Constant	1.509*** (0.245)	1.671*** (0.258)	1.426*** (0.253)
Pseudo R-Square	0.4259	0.4343	0.4349
Observations	1,996	1,820	1,996

Standard errors (S.D.) in parentheses; *** p<0.01, ** p<0.05, * p<0.1

with left alignment interpreted through marginal effect, while the right alignment shows coefficient parameters for dummy variables. The logistic regression result is stated in [Table 2](#).

Based on [Table 1](#), education level has a positive and non-significant effect on the probability of an individual to litter not in place. According to the results above, more other variables significantly affected the likelihood of littering. In this case, the higher level of education – approximated from the long years of schooling– increases the likelihood of littering, but it is not statistically significant. For example, on estimation 3, an increase of 1 year in school will increase the probability of littering by 0.0189 and is not significant (may decrease the likelihood of littering at some points, does not always increase). Education level itself might be not sufficient to explain the probability of littering since formal education material might vary, depending on the institution where the education is taken. With the summary point regarding the littering individual behavior ([Table 3](#)), it is stated that education plays a role in pro-environmental behavior, namely throwing waste in its place.

Lack of knowledge is a determining factor for environmental awareness ([Fransson and Garling, 1999](#)). Environmental behavior or responsibility results from environmental concern. To encourage

the behavior of protecting the environment from waste, it is necessary to transfer knowledge in environmental education ([Wichels et al., 2016](#)). Low environmental education is blamed for the low responsibility behavior towards the environment ([Fransson and Garling, 1999](#)). The utilization of natural resources by humans that causes environmental damage requires more awareness and knowledge from the community itself regarding the impact of their behavior to optimize environmental sustainability. Increased knowledge is associated with increased responsible behavior ([Gunderson et al., 2000](#)). Environmental behavior is based on individual perceptions and attitudes towards environmental problems. This perception will lead to responsible behavior that can be formed through the provision of environmental education. Lack of knowledge causes environmental awareness and responsible behavior towards the environment to weaken ([Alessa et al., 2003](#)). According to action theory, it analyzes that constraints-opportunities will interact with knowledge which will influence individual motives in influencing the implementation of pro-environmental behavior ([Bamberg and Moser, 2007](#)). In other study, waste management through recycling is also associated with knowledge ([Hilburn, 2015](#)). Differences in knowledge can indicate gaps in recycling participation between individuals. Waste

Table 3: Summary point with the individual littering behavior

No	Variables	Summary point
1	Education	<ul style="list-style-type: none"> a. As a determinant of environmental awareness b. Increased responsibility behavior c. Influencing the implementation of pro-environmental behavior d. More educated people are more likely to recycle e. Improving household waste management decisions
2	Environmental Caring	<ul style="list-style-type: none"> a. A clean and healthy lifestyle that encourages waste littering in its proper place. b. A sense of comfort motivates initiatives to practice waste separation behavior. c. Varying levels of sensitivity to nature as a result of social norms, prevalent social norms, infrastructure, and regulations
3	Good Habits	<ul style="list-style-type: none"> a. Higher levels of income and education are also associated with strong environmental management practices. b. Increasing personal awareness of pro-environmental behavior as a resource for maintaining cleanliness.
4	Economic Factors	<ul style="list-style-type: none"> a. The education campaign provided affects not only behavior change, which will indirectly increase income through recycling behavior. b. Households with higher incomes and spending habits lead more clean and healthy lives.

management by prioritizing recycling can be done by combining the factors of public education and available recycling facilities. Knowledge about the impact of inappropriate waste management will be formed from the education given. Education has a contribution to waste management, when the head of the household has a higher level of formal education the probability is higher to littering of waste in its place rather than littering it illegally. In addition to routine information dissemination, valid and persuasive messages, facilities provision, and leading actor's role at the community ([Ruliana et al., 2019](#)), providing education on waste management is also effective way to encourage waste separation. Intensification in waste management education can be taken as the method to encourage management in the form of 3R (reduce, reuse, and recycle) ([Alhassan et al., 2020](#)). Those who are educated are more likely to participate in recycling in California ([Saphores et al., 2006](#)). Education on waste management is important in improving household decisions in waste management, whether it will be dumped in its place or disposed of by illegal disposal - burning, open littering, and landfilling ([Azizi et al., 2016](#)). Through formal education, understanding the community's need for a healthy and hygienic environment can also be improved. Individuals know the impact of illegal waste littering, the impact of burning waste, hoarding inorganic-organic waste, or allowing it to pile up in

public places. Households with a high level of education can be ensured that their waste management is collected and closed properly ([Adzawla et al., 2019](#)). Informal education through campaigns is also accused of being an environmental management strategy through anti-waste campaigns, monitoring, and education in one community ([Carpenter and Wolverton, 2017](#)). The education campaign provided not only affects behavior change which will indirectly increase income through recycling behavior ([Varotto and Spagnolli, 2017](#)). It is stated that environmental damage due to littering, in general, is caused by a lack of knowledge. And provide advice on the need for providing knowledge in formal education from an early age. However, based on the results of this study, the level of education does not provide significant results in encouraging pro-environmental behavior. Pro-environmental behavior is formed due to personal interests and pro-social motives ([Bamberg and Moser, 2007](#)). Urban and richer and more literate households tend to use urban waste collection arrangements ([Kumara and Pallegedara, 2020](#)). On the other hand, several studies have stated that one of the determinants of environmental awareness (disposing of waste in its place) is associated with improving education. It should be noted that these determinants will produce different results between individuals. Besides, the education which is given to the same individual but at

different times will also produce different results ([Fransson and Garling, 1999](#)). The use of instructional media gives insignificant results ([Eastman et al., 2013](#)). The use of education alone is not sufficient to support proper waste littering as may be caused by the unsuitable media used. [Kollmus and Agemyeman \(2002\)](#) that more education does not affect better environmental behavior. [Alhassan and Muhammad \(2013\)](#) also estimate that highly educated people are willing to pay a higher amount of money for better waste management. It is feared that the existence of higher education indeed requires concern for the environment, but they do not carry out their management. They prefer to pay for management by other individuals. Per capita expenditure has a negative and significant relationship to the probability of littering behavior. According to the results above, when the per capita expenditure increases by 1 USD per person per day, it will decrease the probability of littering by -0.0468 (estimation 3). The variable significance at $p<0.01$ (marked by a triple asterisk) indicates that the increase in expenditure per capita as the proxy of wealth and economic status will consistently decrease the probability of littering. This finding confirmed why the wealthy (or economically good district) showed a cleaner environment than the less wealthy districts. This finding also confirmed why a richer individual tend to not litter than to the less one. Similar results are also obtained in the variable of income per capita. For example, a 1 USD increase in income per person per day will decrease the probability of littering by -0.00453 (estimation 2). The marginal effect coefficient shows a negative effect on the probability of littering. Yet, the variable does not show a significant effect due to inconclusive answers on respondents. This result also confirmed that per capita expenditure is still a better approach to measure the economic status of the respondents. Hence on estimation 3, per capita expenditure is only used as the proxy of economic status. The social and economic status of the household influences management indicated by housing with high income is mostly located with a wider, planned and better road network. This allows households to join in the house-to-house waste collection from formal institutions ([Alhassan et al., 2020](#)). Higher levels of income and education are associated with high environmental management habits as well ([Viscusi et al., 2013](#)).

A clean and healthy lifestyle that is associated with education correlates with a clean environment. Thus, a clean and healthy lifestyle will encourage the behavior of littering waste in its place ([Brotosusilo and Handayani, 2020](#)). Households with higher incomes and expenditures have more clean and healthy lifestyles. In addition, to maintain their lifestyle, they will carry out proper waste management so that it does not affect their environment. The careless disposal of waste identic will cause problems in a clean and healthy life. Waste is a direct or indirect source of disease ([Tobing, 2005](#)). Waste is an ideal environment for the growth of various parasites, bacteria, and pathogens. Meanwhile, waste serves as a breeding ground for a variety of vectors (disease carriers) such as rats, cockroaches, flies, and mosquitoes. Pathogens and disease vectors thrive in decomposing waste such as cans, bottles, and plastics. Waste may cause a variety of diseases, including diarrhea, dysentery, intestinal worms, malaria, elephantiasis, and dengue fever. These diseases pose a risk to humans, even cause death. In contrast to what [Fransson and Garling \(1999\)](#) stated, household income has a weak relationship with environmental concerns. The decision to litter is mostly related to attitudes or demographics other than income and welfare ([Adzawla et al., 2019](#)). Efforts that can be made to encourage environmental behavior so that people dispose of waste in its place are by instilling personal awareness about pro-environmental behavior as an asset to maintain cleanliness ([Brotosusilo and Handayani, 2020](#)). The dummy variable in respondents who are quite educated to maintain environmental cleanliness shows a decreasing odds ratio (below one) to the possibility of littering. If an individual is educated enough to keep the environment clean, the probability of littering will be 0.1269 times smaller than if it is not (estimation 3). This dummy variable has been used to estimate the probability of littering since the education level does not answer why more educated people are expected to not litter. This variable has been created from the question of whether formal or informal respondents' educations consistently taught them to avoid littering. The decreasing of this dummy variable confirms one of several aspects on why more educated people aren't littering. It is also added the dummy variable of self-initiative on keeping cleanliness of the environment.

This variable has been created whether the respondents have a self-initiative to keep the environment clean, by littering the waste in the rightful place. This dummy variable also shows decreasing odds ratio to the probability of littering behavior. For example, if an individual has a self-initiative, the probability of them littering will be 0.1732 times lower than those who do not have self-initiative (estimation 3). The result gives this study such an important mark that an initiative on good things will significantly decrease the probability of negative attitude (in this case, littering). Social norms in society are closely related to the behavior of littering. These norms determine the general behavior accepted in the region. When waste is found scattered about not in its place, this can signal the prevailing norm conditions, namely the acceptance of littering. Individual behavior is influenced by cues from the surrounding environment through norm enforcement ([Schultz et al., 2011](#)). Identification of environmental cues can result in misperceptions of waste littering where enforcement of social norms must be carried out properly to spread pro-environmental perceptions and behavior habits ([Weaver, 2015](#)). Social norms are not only related to moral norms but also behavior control ([Bamberg and Moser, 2007](#)). A sense of comfort also encourages initiatives to carry out waste separation behavior ([Alhassan et al., 2020](#)). Personal initiatives on waste littering related to the role of cognitive, emotional, and social interactions. Intention and guilt are the main factors that affect personal initiative. Feelings of guilt when engaging in non-pro-environmental behavior that harms oneself or others. Awareness has a role in environmental responsibility and directly affects the level of control behavior as an attitude of choosing pro-environmental behavior ([Bamberg and Moser, 2007](#)). Each individual has a different level of sensitivity to nature, which comes from social norms, prevailing social norms, infrastructure, and regulations. This factor will influence individual initiative on pro-environmental behavior ([Varotto and Spagnolli, 2017](#)). Personal initiative is an important factor in determining littering through behavior control. Inadequate waste littering facilities are not a cause for littering when the individual has the correct littering initiative. When individuals do not find trash cans, they will not litter and keep their trash and throw it away when they meet the trash can ([Finnie, 1973](#)). Initiative

becomes a reason for proper waste disposal to keep the environment clean and provide an example to other individuals. Awareness becomes the initial capital to maintain environmental cleanliness which fosters individual initiatives to protect the environment ([Brotosiloh and Handayani, 2020](#)). This study tried to explain important factors which might cause a problem in waste management problem from the household side. Through primary data collection, this study explored how households litter their residues of consumption, their decision-making on littering, and their prior knowledge of environmental preservation. A massive share of consumption to GDP in Indonesia also makes this study important since the biggest cities and provinces within the country are surrounded by large waste generation ([Fig. 3](#)). The high share of consumption to GDP also makes most of the waste generated by the country come from household consumption.

Environmental management behavior may be influenced by peer and family pressure, social norm factors, social influences, knowledge, attitudes, and personal factors that affect recycling ([Maki and Raimi, 2016](#); [Varotto and Spagnolli, 2017](#); [Wichels et al., 2016](#)). The practice of waste management consists of collection and littering. Most areas have a formal waste collection service originating from the municipality. The cleaners will collect waste in individual houses or at the communal waste collection points. This study focused on household waste management which is associated with factors that influence their behavior. It is important to find out and understand individual behavior in managing and preserving the environment ([Leonidou et al., 2015](#)). Littering could be prevented by understanding human behavior ([Carpenter and Wolverton, 2017](#)). The dummy variable of good habit also shows that a good habit of environmental caring by not littering will also decrease the probability of littering. The results above indicated that this dummy shows decreasing odds ratio. The example interpretation of this variable is, if an individual has had a good habit (not littering) since childhood, their probability of littering will be 0.2273 times lower than those who do not have a good habit since childhood (estimation 4). The finding of this study showed that good habits since childhood will shape people to be better in society which in this case is to be the non-littering person. It is better if the habit of littering of waste is practiced since childhood before entering school ([Brotosiloh and](#)

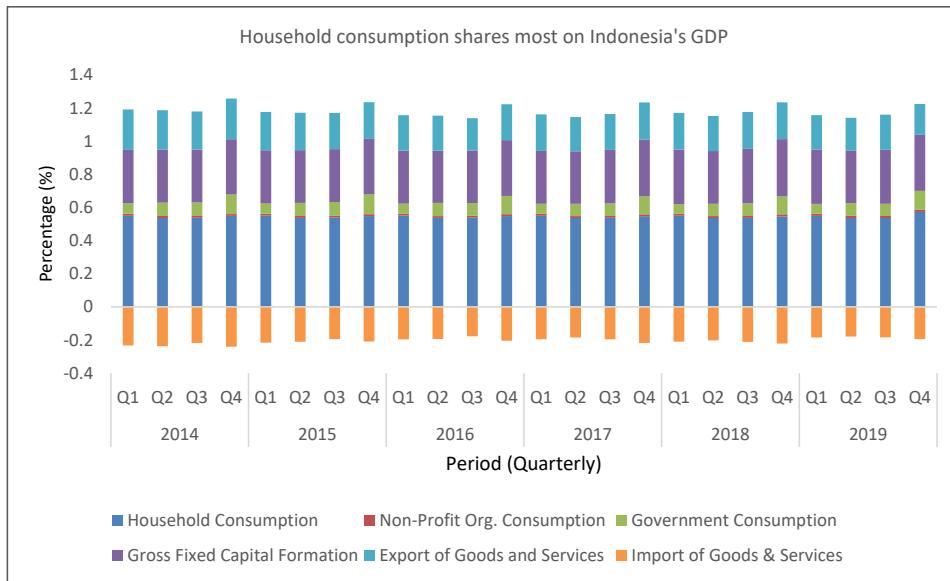


Fig. 3: Share to GDP by expenditure accounts (in decimals) (BPS, 2020)

[Handayani, 2020](#)) as one of the most important ways to teach a person about cleanliness, to keep their living environment clean. In contrast to the opinion of [Cruz et al. \(2012\)](#) which states that good habits are not significantly related to individual behavior. The pro-environmental behavior that is taught since childhood can change due to peer influence. Peers who can influence individuals to engage in anti-environmental behavior (littering) or pro-environment (littering). The presence of other people influences the decision to litter ([Bator et al., 2010](#)) when there is a possibility of decreasing littering. The habit of littering waste is also associated with economy class, when in a better living environment, children will get used to maintaining cleanliness. This can be a driving force for proper littering of waste. The good habits, good economic condition, environmental education, self-initiative and good taught from the parents are not sufficient to decrease the probability of littering. A variable of trash bins unavailability confirms the statement. This dummy, according to the results above, study shows a consistent and significantly increased odds ratio, meaning that although if an individual faces no trash-bins, they will tend to litter. Their probability to litter will be 3.056 times higher (estimation 3) rather than if the trash bins are available. As mentioned by [Hilburn \(2015\)](#), the increase in population density that occurs in cities is a burden in waste management

due to the limited infrastructure available. Availability and affordability of trash bins serve as a reminder for households in waste disposal, and associated facilities have a high impact on waste disposal ([Carpenter and Wolverton, 2017](#)). The availability and affordability of trash bins reduce the behavior of littering ([Bator et al., 2010](#)). Lack of access to formal waste separation facilities and information is an obstacle to household waste separation ([Alhassan et al., 2020](#)). Facilities and information can be in the form of inadequate littering sites, unclear separation information, and short separation times. The lowest level of littering occur when trash bins are available and a short distance away ([Schultz et al., 2011](#)). Optimization of the distance of the trash bin is 20 feet, if the location of the trash bins is more than 20 feet, it will increase littering. This optimization can change depending on the type of waste that is littered. When waste-littering facilities are not available, there is one factor associated with encouraging waste properly, namely social norms ([Schultz et al., 2011](#)). The implementation of social norms for waste disposal can prevent the impact of waste disposal by taking advantage of the role of the surrounding community in cleaning activities. The more that contributes, the more effective it will be to keep the environment clean. The existence of littering facilities alone is not sufficient in waste management; it needs to be synchronized with the waste transportation

performance. Waste collection services influence the behavior of littering (Hilburn, 2015). When the household has littered waste in the trash bins, but the cleaning service authorities do not transport it on time, it can have an impact on the reluctance of households to a litter of waste in its place (Adzawla et al., 2019). This can increase household perceptions about the ineffectiveness of littering of waste properly. Negates the benefits of correct waste collection and reduces household motivation from collecting waste. For this reason, the accuracy of transporting waste from the trash bins is also necessary so that there is no excessive accumulation of waste in the trash bins. There must be control of waste transportation by related officers in a timely and orderly manner. Availability and affordability of waste littering facilities are less effective when there is a high and diverse density of waste littering. Cleaning or transporting waste is less effective if the waste input is higher than the capacity of the available facilities (Carpenter and Wolverton, 2017). The frequency of waste collection, the mode of transportation, and the distance to waste collection affect the choice of household waste management (Rai et al., 2019). Waste management through waste sorting must also be the concern of the relevant government. Efforts made by households to sort waste but are not supported by officers to make the same efforts will make households reluctant to separate waste again (Alhassan et al., 2020). Trash cans classified as inorganic and organic can motivate the community to separate. Otherwise, when officers only mix the waste directly into the garbage truck, it may reduce the motivation for trash separation done by households. Environmental educations are suggested through formal education and family education must be the main primary methods to improve waste management. Effective waste management through sophisticated infrastructures is an enabler for the people who are already aware of the importance of waste handling. Otherwise, if people do not have enough awareness, the problem would persist since the main key drivers of waste management improvements are the people themselves. Environmental educations were found which might face some socio-economic challenges where environmental education through formal entities and families will only be effective on people who had enough income and a certain education level. In the other words, waste management on poor or low-economic class agglomerates can't be done

solemnly without welfare improvement first.

CONCLUSION

This study was built by lack of people's awareness regarding waste littering that most people dispose of waste by burning it. The result shows several important pieces of evidence from citizens in some big cities in Indonesia such as Jakarta, Jambi, Muaro Jambi, Ambon, Padang, Surabaya, and Tasikmalaya during 2019-2021. Good habit (for not littering) since childhood is a supporting factor to decrease littering behavior. A person who implemented littering waste in the right place as a habit since childhood tends to not litter. To build this habit, then formal and informal education is needed. Formal and informal education on keeping the environment clean and self-initiative in environmental caring was found to decrease the likelihood of littering. Formal education taken by the respondents isn't enough to explain the key variables affecting the probability of littering. Informal education is needed and has more impact on the building of citizen's awareness. A person with self-initiative on environmental caring will not litter in incorrect places. Good economic status and condition will be followed by good behavior to not littering a waste. The place where citizens interact and grow was also the factor found that may affect citizen awareness of environmental issues. This is as reflected in the findings that districts with better economic status will tend to be cleaner than the district where less expenditure has per capita. However, good endowments on educational variables and habits are not sufficient to reduce littering if the facilities do not meet the demand. The availability of a trash bin (or littering site) is critical since its unavailability can increase the probability of littering behavior. Therefore, building citizens' awareness should be altogether with building supportive infrastructures accompanied by simultaneous education either formal or informal. From these findings, there is still a question that arises, what type of informal education is preferred and gives more impact to Indonesian citizens on builds they are awareness? This can be a recommendation for future studies.

AUTHOR CONTRIBUTIONS

A. Broto susilo and D. Utari performed conceptualization, methodology, and literature

review. H.A. Negoro performed the validation and formal analysis. A. Firdaus performed review, editing, and visualization. R.A. Velentina performed project administration. All authors have read and agreed to the published version of the manuscript.

ACKNOWLEDGEMENT

This study was funded by KEMENTERIAN RISET DAN TEKNOLOGI/BADAN RISET DAN INOVASI NASIONAL, grant number 8/E1/KP.PTNBH/2021 and grant number [NKB-067/UN2.RST/HKP.05.00/2021] Research and Development (Risbang), Universitas Indonesia. This research under supervision and technical assistance from Cluster of Interaction, Community Engagement and Social Environment, School of Environmental Science, Universitas Indonesia.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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ABBREVIATIONS

*	p<0.1
**	p<0.05
***	p<0.01
	Calculated probability of littering
e	Exponential number
$\beta_0 - \beta_7$	Coefficient parameters
X_1	Education level (years)
X_2	Dummy if respondent educated enough to keep the environment (1=Yes)
X_3	Dummy if respondent has self-initiative to keep clean (1=Yes)
X_4	Dummy if respondent has good habit (not to litter) since childhood (1=Yes)
X_5	Dummy of trash bin unavailability (1=Unavailable)
X_6	Dummy if respondent is taught not to litter since childhood (1=Yes)
X_7	Dummy of Provinces
ε	Error terms
\$	Dollar
3R	Reduce, reuse, and recycle
ASEAN	Association of Southeast Asian Nations
BPS	Statistics Indonesia
Est	Estimation
FDS	Final disposal site
Freq	Frequency
GDP	Gross Domestic Product
HtH	House to house
INF	Informal waste collector
Org	Organization
Prob	Probability
R	Correlation coefficient
SDGs	Sustainable Development Goals
S.D.	Standard deviation
TPA	Final processing site
USD	United states dollar

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HOW TO CITE THIS ARTICLE

Brotosusilo, A.; Utari, D.; Negoro, H.A.; Firdaus, A.; Velentina, R.A., (2022). Community empowerment of waste management in the urban environment: More attention on waste issues through formal and informal educations. *Global J. Environ. Sci. Manage.*, 8(2): 209–224.

DOI: [10.22034/gjesm.2022.02.05](https://doi.org/10.22034/gjesm.2022.02.05)

url: https://www.gjesm.net/article_246468.html

